DEFENSE THREAT REDUCTION AGENCY

BROAD AGENCY ANNOUNCEMENT

HDTRA1-11-16-BRCWMD-Service Call for DoD Degree-Granting Academic Institutions

Amendment 1 (December 2011)

Research and Development Enterprise

Basic and Applied Sciences Directorate

Basic Research for Combating Weapons of Mass Destruction (C-WMD)

March 2011

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1. Introduction and Scope

1.1. This solicitation is an intramural endeavor focused on the basic research needs of DTRA. DTRA has the mission to safeguard America and its allies from WMD and provide capabilities to reduce, eliminate, and counter the threat and effects from chemical, biological, radiological, nuclear, and high yield explosives (CBRNE). DTRA seeks to identify, adopt, and adapt emerging and revolutionary sciences that may demonstrate high payoff potential to counter WMD threats.

1.2. This Service Call solicits white papers for long-term challenges in specific fundamental areas of basic research that offer a significant contribution to the current body of knowledge or further the understanding of phenomena and observable facts and may have impact on future capabilities that support DTRA. Responses to this Service Call must be unclassified and must address **only basic research**. White paper and proposal submissions that address applied research, advanced technology development, or combine basic research with applied research and/or advanced technology development will be considered non responsive and will not be evaluated further.

Basic research is the systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind. It includes all scientific study and experimentation directed toward increasing fundamental knowledge and understanding in those fields of the physical, engineering, environmental, and life sciences related to long-term national security needs. It is farsighted high-payoff research that provides the basis for technological programs.[1]

In contrast to basic research, applied research is the systematic study to understand the means to meet a recognized and specific need. It is a systematic expansion and application of knowledge to develop useful materials, devices, and systems or methods. The boundary between basic research and applied research occurs at the point when sufficient knowledge exists to support a hypothesis involving a specific application.[2]

2. Purpose and Research Topics

2.1. DTRA seeks unclassified, basic research across five major functional counter WMD research thrust areas. Specific research topics that align to one or more thrust areas are presented in Section 10. The five thrust area descriptions are outlined below.

- ***Thrust Area 1—Science of WMD Sensing and Recognition:*** The basic science of WMD sensing and recognition is the fundamental understanding of materials that demonstrate measurable changes when stimulated by energy, molecules, or particles from WMD in the environment. This research thrust involves exploration and exploitation of interactions

[1] DoDI 3210.1, September 16, 2005

[2] DoD Financial Management Regulation Volume 2B, Chapter 5

between materials and various electromagnetic frequencies, molecules, nuclear radiation or particles. These interactions and the specific form of recognition they provide are used for subsequent generation of information that provides knowledge of the presence, identity, and/or quantity of material or energy in the environment that may be significant.

- ***Thrust Area 2—Cognitive and Information Science:*** The basic science of cognitive and information science is the convergence of computer, information, mathematical, networks, natural, and social science. This research thrust expands our understanding of social networks and advances knowledge of adversarial intent with respect to the acquisition, proliferation, and potential use of WMD. The methods may include analytical, computational or numerical, or experimental means to integrate knowledge across disciplines and improve rapid processing of intelligence and dissemination of information.
- ***Thrust Area 3—Science for Protection:*** Basic science for protection involves advancing knowledge to protect life and life-sustaining resources and networks. Protection includes threat containment, decontamination, threat filtering, and shielding of systems. The concept is generalized to include fundamental investigations that reduce consequences of WMD, assist in the restoration of life-sustaining functions, and support forensic science.
- ***Thrust Area 4—Science to Defeat WMD:*** Basic science to defeat WMD involves furthering the understanding of explosives, their detonation, and problems associated with accessing target WMDs. This research thrust includes the creation of new energetic materials or physical approaches that enhance the defeat of WMDs by orders of magnitude, the improvement of modeling and simulation of these materials and various phenomena that affect success and estimate the impact (lethality) of defeat actions, including the assessment of event characteristics using various dynamic analytical methods.
- ***Thrust Area 5—Science to Secure WMD:*** Basic science to support securing WMD includes: (a) environmentally responsible innovative processes to neutralize chemical, biological, radiological, nuclear, or explosive (CBRNE) materials and components; (b) discovery of revolutionary means to secure components and weapons; and (c) studies of scientific principles that lead to novel physical or other tags and methods to monitor compliance and disrupt proliferation pathways. The identification of basic phenomena that provide verifiable controls on materials and systems also helps arms control.

2.2. In Period B, DTRA seeks unclassified, basic research ideas that are responsive to the goals and objectives of the topics outlined in Section 10. The topics labeled "PerB" are only valid for Period B of this Service Call. Only white papers responsive to the topics posted for Period B and submitted by the Period B deadline by eligible applicants will be considered. A new list of topics will be developed for subsequent periods with corresponding white paper due dates.

2.3. Topics for future periods with corresponding white paper due dates will be accomplished via amendments to this solicitation. Topics from previous period(s) may or may not be repeated. DTRA will not provide additional information regarding the posting of future topics, including dates for posting, the potential for a topic to be repeated in out years, the potential for similar topics to be posted, and/or topic details in advance of issuance of an amended Service Call.

2.4. This Service Call, in addition to any amendments issued in conjunction with this Service Call, will be posted to the DTRA Submission Website (www.dtrasubmission.net), the DTRA Basic and Fundamental Research Community Portal (www.dtrasubmission.net/portal) and to the DTRA website (www.dtra.mil).

2.5. The DTRA Basic and Fundamental Research Community Portal (www.dtrasubmission.net/portal) is available to all applicants. Information available at the portal includes, but is not limited to, the following: a detailed timeline for this Service Call, templates that may be used when preparing white papers and invited proposals, an update on the status of submission(s), and a link to USASpending.gov for a list of previous awards made by the Basic Research for C-WMD Program.

3. Award Information

3.1. Resulting awards from this announcement will be Military Interdepartmental Purchase Requests (MIPRs). The final number of projects and funds allocated will be determined after all proposals are received and evaluated.

3.2. There are two categories of awards, which are detailed below. The applicant does not need to specify the type of award sought. It will be inferred by the dollar amount requested and/or the topic to which the white paper is submitted.

- Single Scope Awards: Research projects that focus on exploratory aspects of a unique problem, a high risk approach, or innovative research in a subject with potential for high impact to C-WMD science. Research must support undergraduate and/or graduate students, and/or postgraduate students.

  Single Scope Awards may have Co-Principal Investigators (Co-PIs), sub-awards, and/or sub-contracts. Single Scope Awards will be made by a single MIPR to the lead organization. Sub-awards, including all sub-contracts, are the responsibility of award recipient; exceptions will not be made.

  Single Scope Awards will average $150K per year. Single Scope Awards may have a period of performance (POP) of up to five (5) years. Awards are typically for a base period of three (3) years with two (2) additional years possible as options. Proposals that outline scope and effort for a three (3) year base period and do not propose options are also acceptable.

  The predominance of awards will be Single Scope Awards.

- Multidisciplinary Awards: Research Projects that involve a comprehensive program of innovative research in an interdisciplinary area with potential for high impact. The proposed research must involve fundamental contributions in research by multiple investigators from diverse disciplines (proposal **must** be multidisciplinary). Investigators may be from a single institution or multiple institutions. Research must support multiple undergraduate and/or graduate students, and/or postgraduate students.

Authors of these white papers and invited proposals must take great care to clearly outline the impact to C-WMD science that is to be gained from the higher dollar amount investment and justify the scientific contribution from each investigator.

Proposals submitted under this category must have a single lead organization and single submission for the white paper and the invited proposal. Multidisciplinary Awards will be made by a single MIPR to the lead institution. Sub-awards, including all sub-contracts, are the responsibility of award recipient. Exceptions will not be made.

Multidisciplinary Awards will average $350K per year. Multidisciplinary Awards may have a POP of up to five (5) years. Awards are typically for a base period of three (3) years with two (2) additional years possible as options. Proposals that outline scope and effort for a three (3) year base period and do not propose options are also acceptable.

3.3. Funding for participation in this program is highly competitive and the cost of proposed research should strictly be maintained in the award amounts outlined for each award type and for each topic. Under no circumstances will awards exceed 10% of the averages as outlined for each award type and for each topic. Exceptions will not be made.

3.4. Sub-contracts are permitted. Sub-contracts may be used to carry out a portion of the research. DTRA will review and consider the proposed sub-contracts for all applications on a case-by-case basis.

Any applicant submitting a proposal for an award that has subcontracting possibilities must submit a subcontracting plan in accordance with FAR 19.704(a) (1) and (2). This information, if applicable, must be included in Volume III, Supplemental Information, of the Phase II full proposal. The plan format is outlined in FAR 19.7.

3.5. Funding Restrictions. Indirect costs may be restricted to less than 35% of the total award value. The 2008 DoD Appropriations Act (Public Law 110-116, Section 8115), 2009 DoD Appropriations Act (Public Law 110-329, Section 8109), and the 2010 DoD Appropriations Act (Public Law 111-118, Section 8101) applied this restriction to awards made using fiscal year 2008, 2009, and 2010 Basic Research funds. This restriction does not apply to awards made using fiscal year 2011 Basic Research funds but **may** apply to future awards.

3.6. The Government will not provide any hardware or software to execute the proposed research.

3.7. The Government reserves the right to fund all, some, or none of the proposals submitted; may elect to fund only part of any or all proposals; and may incrementally or fully fund any or all awards under this Service Call. All awards are subject to the availability of funds.

4. Eligibility

4.1. DoD degree-granting academic institutions that are Federal government organizations, e.g. United States Military Academy at West Point, The Air Force Institute of Technology, etc., are eligible to submit white papers and proposals in response to this intramural Service Call.

4.2. There is no limit on the number of white papers and invited proposals that an applicant (PI/Co-PIs) may submit in response to this Service Call.

- Applicants (PI/Co-PIs) may submit white papers and invited proposals to one or more topics.

- Applicants (PI/Co-PIs) may submit white papers and invited proposals to one or more periods under this Service Call, regardless of a previous submission's disposition.

- Applicants (PI/Co-PIs) are **strongly** encouraged to minimize overlap in scope and level of effort if multiple projects are submitted for white papers and invited proposals. Further, individual PIs and Co-PIs are discouraged from repackaging research and submitting multiple redundant Phase I submissions in any given period of this Service Call.

5. Submission Information

This solicitation will be conducted in two phases: Phase I is for submission of white papers. Phase II is by invitation only and is based on the evaluation results of Phase I. The invitation to submit a Phase II proposal will be based on the evaluation results in Phase I.

The submission deadline for Period B Phase I white paper receipt is listed in Section 6.

5.1. General Application and Submission Information.

5.1.1. All applicants interested in submitting proposals must register on the DTRA proposal submission website, http://www.dtrasubmission.net, prior to submission of a white paper(s) and proposal(s). Each institution may establish procedures for the management of registration and submission of proposals. Detailed registration instructions are available at the website. Failure to register in accordance with instructions will prevent submission of the required documents and render applicants ineligible for participation in this Service Call. Prior registration at any other proposal submission site other than at http://www.dtrasubmission.net does not fulfill registration requirements for participation in this Service Call.

5.1.2. Proposals must be submitted electronically through the DTRA proposal submission website, http://www.dtrasubmission.net. Do not submit any classified materials to the Service Call or to the proposal submission website. Unclassified proposals submitted by any means other than the DTRA proposal submission website (e.g., hand-carried, postal service mail, commercial carrier, or e-mail) will not be considered. Detailed submission instructions are available at the website.

5.1.3. Applicants are responsible for ensuring compliant and final submission of their white papers and/or proposals, and can verify the submission of the white paper and/or proposal package with the electronic receipt that appears on the screen following compliant submission of a proposal to the DTRA proposal submission website.

5.1.4. Using the DTRA proposal submission website, all applicants must prepare cover sheets for each Phase I white paper and invited Phase II proposal submitted. All data point requirements must be completed in every cover sheet. Once the cover sheet is saved, the system will assign a unique proposal number for each Phase I submission and a different unique proposal number for each invited Phase II submission. Cover sheets may be edited as often as necessary until the submission period closes.

5.1.5. If multiple proposals are being submitted by the same institution, separate cover sheets must be generated for each white paper and proposal as the required documents must be uploaded with the associated cover sheet, since a unique document number will automatically be assigned to each submission by the electronic proposal tracking system. All documents submitted to the DTRA proposal submission website are considered works in progress and are not eligible for evaluation until the applicant submits the final proposal package for consideration. The final submission must be 'locked' on the DTRA proposal submission website; until a submission has been 'locked' (saved as final), the submission is not eligible for review. Look for this 'lock' icon  on the DTRA proposal submission website. Applicants are responsible for ensuring compliant and final locked submission of their white papers and proposals; applicants can verify the submission of the white paper and proposal package with the electronic receipt that appears on the screen following submission of a white paper and proposal to the DTRA proposal submission website.

5.1.6. The white paper and all parts of the proposal must be uploaded in a Portable Document File (PDF) format compatible with Adobe Acrobat ® version 9.0 or earlier. Files must not exceed 2 Megabytes of storage space (uncompressed). Movie and sound file attachments or other additional files will not be accepted. Perform a virus check before uploading proposal files. If a virus is detected, it may cause rejection of the file. Uploaded files must not be password protected or encrypted.

5.2. DTRA will not review any of the following:

- White papers that attempt to address multiple topics.
- White papers that are submitted to topics from previous periods.
- Proposals for Phase II submissions that were not invited.

5.3. Phase I White Paper Submission and Content.

Interested applicants are required to submit a four-page white paper. Each white paper must address only one of the Period B research topics detailed in Section 10.

5.3.1. Cover Sheet Information: The following information is required to complete a Cover Sheet for each white paper and proposal:

- Topic Number under which white paper/proposal is being submitted for consideration
- Title of proposed effort, which must be different than the topic title

- Applicant Institution name and address (this is based on the registrant submitting the proposal, and should be the institution, not the individual)
- Estimated Cost per year of performance
- Information on other submissions of same proposed effort
- Contact Information for PI and Business Points of Contact – Name, Title, Phone, Fax and Email
- Identification of proprietary information included in proposal submission (page numbers)
- Technical Abstract. The project abstract should be concise (less than 250 words) and provide a summary of the proposed work and demonstrate relevance to the topic being addressed. The abstract should not contain any proprietary data or markings.
- Key Words/Phrases (limited to 8 key words)

The Cover Sheet is automatically populated with the following information:

- DUNS, CAGE and Tax ID numbers, as entered during registration (cannot be changed)
- Applicant, as entered during registration (cannot be changed)
- Address (can be updated)

5.3.2. White Paper Narrative Format: The white paper itself should provide sufficient information on the research being proposed (e.g., the hypothesis, theories, concepts, approaches, data measurements, and analysis, etc.) to allow for an assessment by a technical expert.

Any pages submitted for the white paper that exceed the limit of four pages will not be read or evaluated. A page is defined as 8 1/2 x 11 inches, single-spaced, with one-inch margins in type not smaller than 12 point Times New Roman font. The white paper must be provided in portrait layout.

At minimum, the white paper should address the following:

- Potential scientific impact to provide greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts, including how the research contributes to the C-WMD science needs outlined in the topic.
- The impact of the research on C-WMD science must be clearly delineated.
- Cost estimate by year and total dollars required to accomplish the research as presented in the white paper (no details or breakout of costs is required).
- Potential team and management plan, including details on student involvement.
- Multidisciplinary white papers should carefully detail each of the institutions/departments involved and the contribution that will be made by each of the investigators.

- Do NOT include corporate or personnel qualifications, past experience, or any supplemental information with the white paper.
- The topic number and name should be included as a header on the white paper and in the text of the white paper.

5.4. Phase II - Full Proposal Submission and Content.

The full proposal must be prepared in three separate volumes: Volume I – Technical Proposal; Volume II – Cost Proposal; and Volume III – Supplemental Information, to include an SOW and a Quad Chart.

5.4.1. Cover Sheet Information: The information described above in Section 5.3.1 is required to complete a Cover Sheet for each proposal in Phase II.

5.4.2. Technical Proposal: The technical proposal must not exceed 20 pages (including references). If the proposal exceeds 20 pages, only the first 20 pages will be reviewed. A page is defined as 8 ½ x 11 inches, single-spaced, with one-inch margins in type not smaller than 12 point Times New Roman font. The proposal must be provided in portrait layout. A **template** for the technical proposal format may be found online at www.dtrasubmission.net/portal (Microsoft Word format).

The technical proposal must include the following components:

- ***Abstract.*** The project abstract should be concise (less than 250 words) and provide a summary of the proposed work and demonstrate relevance to the topic being addressed. The abstract should not contain any proprietary data or markings.
- ***Scope.***
  - ***Objective.*** A clear and concise objective of the proposed project.
  - ***Background.*** Provide the necessary technical and scientific background to support the scientific and/or technical merit of the proposed project.
  - ***Programmatics***. Describe your organization's management plan for the proposed project; list supporting and collaborating centers, and the roles/responsibilities of each identified academic and/or industrial sub-contractor supporting the project. Authors of multidisciplinary proposals must take great care to clearly outline the impact to C-WMD science that is to be gained from the higher dollar amount investment and justify the scientific contribution from each investigator.
  - ***Relevance.*** Describe the relevance of the proposed project in terms of advancing the state of the science and the anticipated scientific impact on capabilities to potentially reduce, eliminate, counter, provide greater knowledge or understanding of the threat, and mitigate the effects of WMD fundamental aspects of phenomena and of observable facts.
- ***Credentials.*** Describe the PI's qualifications and the organization's qualifications to perform the proposed work. Summarize the credentials of the primary performing center, and supporting academic and industrial partners to perform the work. Describe specific examples of equipment and/or facilities available to perform the proposed work. Focus on information directly relevant to the proposed work.

- ***Work to be Performed.*** Provide details of the work to be performed by task and subtask. Tasks must be grouped by project year.
- ***Performance Schedule.*** Provide a table of tasks and sub-tasks and the duration of performance of each in a Gantt or other suitably formatted chart.
- ***References.*** List any relevant documents referenced.

5.4.3. Volume II – Cost Proposal: The Cost Proposal should contain cost estimates sufficiently detailed for meaningful evaluation with a break-down of costs on an annual basis and by task. A narrative supporting the costs should also be included. The Cost Proposal does not have a page limit and may be provided in the applicant's preferred format. The Cost Proposal must be uploaded as a separate Portable Document File (PDF) compatible with Adobe Acrobat ® version 9.0 or earlier. A PDF is requested to ensure formatting remains consistent and appropriate.

The Cost Proposal should include the following information:

- Individual labor categories or persons (principal investigator, graduate students, etc.), with associated labor hours and unburdened labor rates.
- Benefits and labor burden costs.
- Subcontract costs and type (the portion of work to be subcontracted and rationale). Submit a detailed description of the proposed subcontracted effort(s) and the projected cost(s). Note that separate cost proposals should be provided and incorporated into Volume II for any subcontracts.
- Consultant fees (indicating daily or hourly rate) and travel expenses and the nature and relevance of such costs. Note that separate cost proposals should be provided and incorporated into Volume II for any consultants.
- Travel costs and the relevance to stated objectives; number of trips, destinations, duration, if known and number of travelers per trip. Travel cost estimations should be based on the Joint Travel Regulations (JTR).
- Publication and report costs.
- Estimate of material and operating costs.
- Cost of equipment, based on most recent quotations and itemized in sufficient detail for evaluation. Clearly delineate any computer or IT equipment purchases.
- Communications and publications costs not included in overhead.
- Other Direct Costs.
- Indirect costs.[3]

Applicants shall plan and budget for travel to accommodate the two meetings outlined as follows:

[3] Indirect costs may be restricted to less than 35% of the total award value regardless of previously negotiated rates with the cognizant agency. The 2008 DoD Appropriations Act (Public Law 110-116, Section 8115), 2009 DoD Appropriations Act (Public Law 110-329, Section 8109), and the 2010 DoD Appropriations Act (Public Law 111-118, Section 8101) applied this restriction to awards made using fiscal year 2008, 2009, and 2010 Basic Research funds and **may** apply to future awards.

- National Conferences/Workshops/Symposia: Applicants are strongly encouraged to attend a nationally recognized conference, workshop, or symposium in the field of research each calendar year (1 at minimum). Research should be presented as soon as adequate data are available to support posters and presentations. Conferences/workshops/symposia should be attended by the PI and students supporting the research, as appropriate.

- Annual Technical Review: Applicants should plan to attend an annual technical program review meeting. For planning purposes the review will be for five days and will be held in Northern Virginia. DTRA encourages graduate students to attend the Annual Technical Review.

5.4.4. Volume III – Supplemental Information: This volume contains supplemental data. This volume must contain the items detailed as follows:

- A Quad chart for the effort must be uploaded. Please see below for details.
- A Statement of Work defining the major tasks and timelines for the effort must be uploaded. Please see below for details.
- A brief summary of any proposed Human Subjects research, or a confirmation that the proposed effort does not include Human Subjects research, must be entered.
- A brief summary of any proposed Animal Subjects research, or a confirmation that the proposed effort does not include Animal Subjects research, must be entered.
- A brief summary of any proposed Biosurety and Select Agent research, or a confirmation that the proposed effort does not include Biosurety and Select Agent research, must be entered.
- A statement of any potential Organizational Conflicts of Interest, or a confirmation of no conflicts, must be entered.
- A statement of Intangible Property Assertions.
- Authorized Offeror Personnel: Applicants must include the name, title, mailing address, telephone number, fax number, and e-mail address of the company and business point of contact regarding decisions made with respect to the applicant and who can obligate the proposal contractually. Also, identify those individuals authorized to negotiate with the Government.
- A statement outlining any current and pending support related to the proposed effort must be entered. This information must be included for each investigator listed in the proposal. This statement requires that each investigator specify all grants and contracts through which he or she is currently receiving or may potentially receive financial support.
- A Cost Summary, which is a form that captures the following total costs by year (this summary includes total numbers only; supporting detail is included in the Cost Proposal):
    - Direct Labor
    - Fringe Benefits

- □ Subcontract Costs
- □ Domestic Travel Costs
- □ Foreign Travel Costs
- □ Tuition Costs
- □ Direct Materials and Supply Costs
- □ Direct Equipment Costs
- □ Publication Costs
- □ Other Direct Costs
- □ Indirect Costs[4]

Quad Chart: The quad chart must be presented on 1 page. The quad chart must not contain any proprietary data or markings. The quad chart must be provided in landscape layout. A **template** for the quad chart format may be found online at www.dtrasubmission.net/portal (Microsoft PowerPoint format). A pictorial representation of the quad chart is provided in Figure 1 and includes the relevant fields that must be included in the Phase II proposal submission. The inclusion of the DTRA logo is not required.

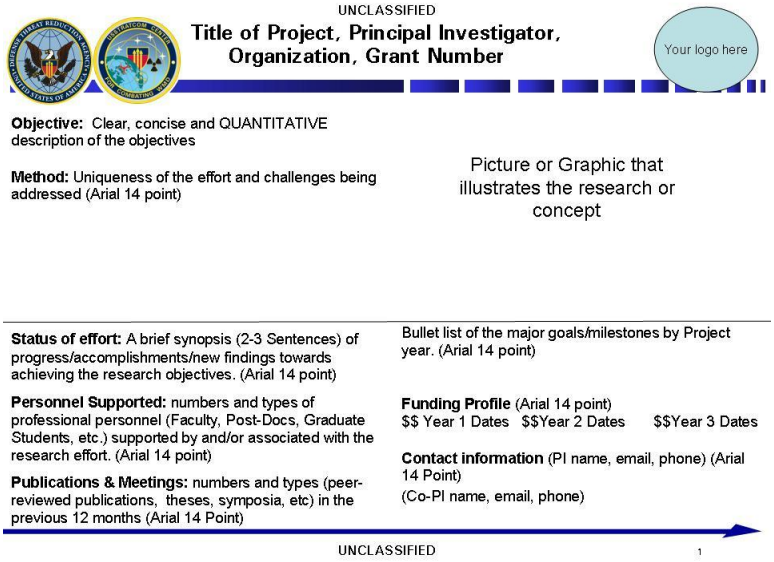

Figure 1: Pictorial representation of the quad chart.

[4] Indirect costs may be restricted to less than 35% of the total award value regardless of previously negotiated rates with the cognizant agency. The 2008 DoD Appropriations Act (Public Law 110-116, Section 8115), 2009 DoD Appropriations Act (Public Law 110-329, Section 8109), and the 2010 DoD Appropriations Act (Public Law 111-118, Section 8101) applied this restriction to awards made using fiscal year 2008, 2009, and 2010 Basic Research funds and **may** apply to future awards.

SOW: SOW does not have a page limit, but should be approximately 3-5 pages in length for incorporation into award. The SOW should not contain any proprietary data or markings. Pages should be numbered and the initial page should have a date (document date) shown under the title (the title of the SOW should match that of the proposal). The SOW must be provided in portrait layout. A **template** for the SOW format may be found online at www.dtrasubmission.net/portal (Microsoft Word format).

The proposed SOW must accurately describe the research to be performed. The proposed SOW must also contain a summary description of the technical methodology as well as the task description, but not in so much detail as to make the SOW inflexible. The SOW format/guidance is as follows:

- ***Objective:*** Brief overview of the specialty area. Describe why the research is being pursued and what knowledge is being sought.

- ***Scope:*** Include a statement of what the SOW covers including the research area to be investigated, objectives/goals, and major milestones and schedule for the effort.

- ***Background:*** The applicant must identify appropriate documents, including publications that are applicable to the research to be performed. This section includes any information, explanations, or constraints that are necessary in order to understand the hypothesis and scientific impact on capabilities needed to reduce, eliminate, and counter the threat, and also mitigate the effects of Weapons of Mass Destruction (WMD). It may also include previously performed relevant research and preliminary data.

- ***Tasks/Scientific Goals:*** This section contains the detailed description of tasks which represent the research to be performed that are contractually binding. Thus, this portion of SOW should be developed in an orderly progression and presented in sufficient detail to establish the methodology and feasibility of accomplishing the overall program goals. The work effort should be segregated by performance period for all tasks to be performed and anticipated milestones realized in that year (e.g., Year 1, Year 2, etc, should be detailed separately). Identify the major tasks in separately numbered sub-paragraphs. Each major task should delineate, by subtask, the research to be performed by year and each task should be numbered using the decimal system (e.g. 4.1, 4.1.1, 4.1.1.1, 4.2, etc.). The sequence of performance of tasks and achievement of milestones must be presented by project year and task in the same sequence as in the Technical Proposal. The SOW must contain every task to be accomplished to include a detailed schedule.

  The tasks must be definite, realistic, and clearly stated. Use "the awardee shall" whenever the work statement expresses a provision that is binding. Use "should" or "may" whenever it is necessary to express a declaration of purpose. Use "will" in cases where no applicant requirement is involved; e.g., power will be supplied by the Government. Use active voice in describing work to be performed. Do not use acronyms or abbreviations without spelling out acronyms and abbreviations at the first use; place the abbreviation in parenthesis immediately following a spelled-out phrase. If presentations/meetings are identified in your schedule, include the following statement in your SOW: "Conduct presentations/meetings at times and places specified in the award schedule."

- ***Deliverables:*** The deliverables must include the following:

  - □ Annual Research Performance Progress Report(s): Annual progress reports will be due no later than 1 September of each year. Awards effective after 31 May will not require a progress report until 1 September of the following year. A Technical Reporting Guide may be found online at the www.dtrasubmission.net/portal.

  - □ Annual Quad Chart(s)

  - □ Annual Research Summary(ies): The Research Summary is a short (less than one page) description of the research objectives and current status.

  - □ Annual Metrics Survey

  - □ Research Performance Final Report: A comprehensive final technical report is required at the end of an effort, due before the end of the period of performance. A Technical Reporting Guide may be found online at the www.dtrasubmission.net/portal.

    The final report will always be sent to the Defense Technical Information Center (DTIC) and reports may be available to the public through the National Technical Information Service (NTIS).

  - □ Invention Reports: Invention reports must be filed annually using DD Form 882 Reporting of Inventions and Subcontracts in accordance with the published instructions for the form **IF** the awardee has a reportable event. Negative reports are not required. The submission of the DD Form 882 is required at the conclusion of all awards.

  - □ The Federal Financial Report, SF425 is due annually, no later than 30 days after the end of the reporting period for all awards. The reporting period shall be from 1 July– 30 June. First year reports shall have a reporting period of the start date of the MIPR through 30 June. Final reports shall be submitted no later than 90 days after the project or MIPR period end date. Applicants should note that Section 11 of the SF425 "Indirect Expense" must be completely in its entirety.

5.5. Marking of White Paper and Proposal and Disclosure of Proprietary Information other than to the Government.

The white paper/proposal submitted in response to this Service Call may contain technical and other data that the applicant does not want disclosed to the public or used by the Government for any purpose other than proposal evaluation. Public release of information in any white paper/proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information which constitutes a trade secret, proprietary commercial or financial information, confidential personal information, or data affecting the national security, is provided by an applicant in a white paper/proposal, it will be treated in confidence, to the extent permitted by law, provided that the following legend appears and is completed on the front of the white paper/proposal: "For any purpose other than to evaluate the white paper/proposal, this data shall

not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if an award is made to the applicant as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the agreement. This restriction does not limit the right of the Government to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s) _____ of this White Paper/Proposal."

Any other legend may be unacceptable to the Government and may constitute grounds for removing the Proposal from further consideration without assuming any liability for inadvertent disclosure.

The Government will limit dissemination of properly marked information to within official channels. In addition, the pages indicated as restricted must be marked with the following legend: "Use or disclosure of the white paper/proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the front page of this white paper/proposal."

The Government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event that properly marked data contained in a white paper/proposal submitted in response to this Service Call is requested pursuant to the Freedom of Information Act (FOIA), 5 U.S.C. § 552, the applicant will be advised of such request and, prior to such release of information, will be requested to expeditiously submit to DTRA a detailed listing of all information in the white paper/proposal which the applicant believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the applicant will ensure that any information released by DTRA pursuant to the Act is properly identified.

By submission of a white paper/proposal, the applicant understands that proprietary information may be disclosed outside the Government for the sole purpose of technical evaluation. The Program Coordinator will obtain a written agreement from the evaluator that proprietary information in the white paper/proposal will only be used for evaluation purposes and will not be further disclosed or utilized.

5.5.1. Export Control Notification. Applicants are responsible for ensuring compliance with any export control laws and regulations that may be applicable to the export of and foreign access to their proposed technologies. Applicants may consult with the Department of State with any questions regarding the International Traffic in Arms Regulation (ITAR) (22 CFR Parts 120-130) and/or the Department of Commerce regarding the Export Administration Regulations (15 CFR Parts 730-774).

5.5.2. White papers and proposals may be withdrawn by written notice received at any time before award. Withdrawals are effective upon receipt of notice by the Program Coordinator via the e-mail address listed in Section 9.

6. Submission Dates and Times

6.1. White papers will be accepted based on periods as outlined in Table 1 (below). The due date for the Phase II invited proposal submissions will be provided in the letter of invitation. Applications will not be reviewed if they are received after these deadlines. Additional timeline details are available to all applicants at www.dtrasubmission.net/portal, e.g. notification date for proposal invitations. Applicants are responsible for checking the www.dtrasubmission.net/portal for changes and updates to the schedule.

6.2. Applicants are responsible for submitting white papers and invited proposals so as to be received by the DTRA submission site by the time and dates listed in Table 1 (below) and the letter of invitation for proposals, respectively. When sending electronic files, the applicant should allow for potential delays in file transfer from the originator's computer server to the Government website/computer server. Applicants are encouraged to submit their proposals early to avoid potential file transfer delays due to high demand encountered as the submission deadline approaches.

6.3. Please note 15 USC 260a establishes daylight saving time as the standard time during the daylight saving period.

6.4. Additional opportunities for white paper submissions with applicable topics, due dates, and application packages will be posted as amendments to this Service Call. Schedules of future amendments, topic information and due dates will not be provided and questions requesting information relevant to future amendments, schedules and/or topics will not be answered in advance of an amendment.

Date	Event
1 March 2011	Service Call announced on www.dtrasubmission.net/portal
Period A	
CLOSED	
~~2:00 PM EST, 8 April 2011~~	~~Phase I white paper receipt deadline~~
~~September 2011—March 2012~~	~~Period A awards~~
January—March 2012	Period A MIPRs scheduled to be awarded
Period B	
1 December 2011	Amendment to the Service Call announced on www.dtrasubmission.net/portal with Period B topics and white paper receipt deadline
2:00 PM EST, Not prior	Phase II invitation-only proposal receipt deadline

to 2 April 2012, and not later than 20 April 2012 *	* The exact due date for the full proposals will provided in the letters of invitation
2:00 PM EST, 13 January 2012	Phase I white paper receipt deadline
October—December 2012	Period B awards
Period C	
TBD	Amendment to the Service Call announced on www.dtrasubmission.net/portal with Period C topics and white paper receipt deadline
TBD	Phase I white paper receipt deadline
TBD	Period C awards
Period D	
Period E	
Period F	
Period G	
Period H	
…….	
Period 'n'	

Table 1: List of important dates.

6.5. Acceptable evidence to establish the time of receipt at the Government office includes documentary and electronic evidence of receipt maintained by DTRA. Applicants should also print, and maintain for their records, the electronic receipt following submission of a white paper and proposal to the DTRA submission site.

6.6. If the white paper and invited proposals are submitted to the DTRA submission site after the exact time and date specified in this Service Call for the white paper and the letter of invitation for the invited proposal, the submission is "late" and will not be considered. Exceptions will not be considered.

6.7. If an emergency or unanticipated event interrupts normal Government processes so that proposals cannot be submitted to the DTRA submission site by the exact time specified in this Service Call for the white paper and the letter of invitation for the invited proposal, and urgent Government requirements preclude amendment of the Service Call closing date, the time specified for receipt of submissions will be deemed to be extended to the same time of day specified in the Service Call on the first work day on which normal Government processes resume.

7. Application Review information

7.1. Evaluation Criteria. The evaluation criteria to be used for review of applications are listed below. Only the first two criteria will be used to evaluate white papers; all four will be used to evaluate invited proposals.

1. Technical/Scientific Merit. This area addresses the technical approach and the contribution of the research to advancing the scientific body of knowledge. It evaluates what research will be performed and how it will be accomplished. Three factors will be considered. The factors are listed in the order of importance.

   - *Soundness of Approach.* This factor addresses whether the proposal clearly identifies and demonstrates an understanding of the scientific challenges and whether the project has a well-designed methodology, based on sound scientific principles, and how technical risks are addressed, mitigated, and managed.
   - *Degree of Innovation.* This factor addresses the originality of the concept, its scientific merit, its creativity, and/or the novelty of the approach and the potential of the project to advance the scientific body of knowledge. The degree of innovation will be judged based on the innovation or originality that is appropriate to the proposed project.
   - *Anticipated Scientific Impact.* This factor addresses the potential of the proposed work to provide greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts and the anticipated impact on the state of the science.

2. Responsiveness to Topic Area and Program. This area evaluates the extent to which the proposed research supports specific topic areas. It also considers the derivative benefit that may be realized by the performer and its organization through performance of the proposed research. The two factors are weighted equal to each other.

   - *Responsiveness to Topic Area.* This factor addresses the responsiveness of the proposal to the objectives in the specific topic area and the contribution to the C-WMD science needs outlined in the topic.
   - *Derivative Benefit.* This factor considers training of students in science, engineering, and/or mathematics through the proposed research.

3. Program Capabilities. This area addresses key personnel, facilities, and major equipment required to accomplish the research. The two factors are weighted equal to each other.

   - *Qualifications.* This factor will be scored based on the qualifications and availability of the proposed PI, co-PIs and other key personnel who are critical in achieving proposed objectives.
   - *Capabilities.* This factor considers the applicant's current or planned facilities and equipment that support achieving the proposed objectives. Capabilities evaluation will be based on the total capabilities of the assembled team that will be brought to bear as part of the proposed project.

4. Cost Realism and Reasonableness. This factor considers the adequacy and reasonableness of resources applied to each project task. This includes labor (in terms of time and mix), equipment, other direct costs, and indirect costs.

7.2. Review and Selection Process.

The white paper and proposal selection process will be conducted based upon a technical review and includes the use of non-government peer-reviewers. Each white paper and invited proposal will be reviewed within the period to which it was submitted.

7.2.1. White paper (Phase I) evaluation will be based on 2 equally weighted criteria described in Section 7.1: 1.) Technical/Scientific Merit and 2.) Responsiveness to Topic Area and Program, which will each be scored as Green (acceptable), Yellow (acceptable with minor issues), or Red (unacceptable). The Government reserves the right to limit the number of Phase II invited proposals requested depending upon the volume of white papers submitted, the results of the Phase I evaluation, and the specific needs of the Agency.

7.2.2. Invited Proposal (Phase II) Evaluation will be based on the 4 criteria described in Section 7.1. Criteria 1. Technical/Scientific Merit and Criteria 2. Responsiveness to Topic Area and Program are equally weighted and are more important than Criteria 3. Program Capabilities which is more important than Criteria 4. Cost Realism and Reasonableness. All 4 criteria receive a numerical score ranging from 1 (unacceptable) to 5 (outstanding).

7.2.3. Other factors that may be considered during the selection process are the possible duplication with other research currently funded by the Government, program balance across research topics, and budget limitations. Accordingly, proposals may be selected for funding which are not reviewed as highly as others, which are of higher risk and/or which may be of a higher cost.

7.2.4. The Government reserves the right to select all, some, or none of the proposals, or any part of any proposal, received in response to this Service Call and to make awards without discussions with applicants; however, the Government reserves the right to conduct discussions if determined necessary.

7.2.5. Additional details, including the due date, for Phase II submissions may be provided to applicants in the invitation email.

7.3. Technical and Administrative Support by Non-Government Personnel

7.3.1. It is the intent of DTRA to use non-government personnel to assist with the review and administration of submittals for this Service Call.

7.3.2. All invited proposals will be reviewed by subject matter experts (peer reviewers) who are non-government personnel.

7.3.3. Participation in this Service Call requires DTRA support contractors to have access to white paper and invited proposal information including information that may be considered proprietary. Existing DTRA contractors include but may not be limited to the following: TASC

Inc. (advisory and assistance services) and their subcontractors, Suntiva Executive Consulting (contract specialist support) and their subcontractors, BRTRC Inc., SBG Technology Solutions, and Terremark Worldwide Inc. Each contract contains organizational conflict of interest provisions and/or includes contractual requirements for non-disclosure of proprietary contractor information or data/software marked with restrictive legends.

7.3.4. All individuals having access to any proprietary data must certify that they will not disclose any information pertaining to this Service Call including any submittal, the identity of any submitters, or any other information relevant to this Service Call.

7.3.5. All applicants to this Service Call consent to the disclosure of their information under these conditions.

8. Award & Notification Information

8.1. Applicants of white papers that are not selected for invitation will be notified of the decision by e-mail at all of the addresses provided at the time of submission.

8.2. An invitation to submit a proposal will be extended to those applicants whose submissions were selected in Phase I. The invitation will be transmitted via e-mail to all of the email addresses provided at the time of submission.

8.3. Applicants will be notified by DTRA of their selection/non-selection for award from the Phase II invited proposals via email to all of the email addresses provided at the time of submission. Notification of proposal selection is not an authorization to begin work.

8.3.1. A notice of selection should not be construed as an obligation on the part of the Government; only duly authorized procurement personnel may commit resources, this will be done by issuing a MIPR document to the selected applicant. Also, this notification must not be used as a basis for accruing costs to the Government prior to award. Selected applicants are not authorized to begin work, as any award is subject to successful negotiations (if determined necessary by DTRA) between the DTRA contracting division and the selected organization, and to the availability of funds.

8.4. A debrief summary will be provided as part of all notification emails.

8.5. All notifications will be made from notification@dtrasubmission.net. **E-mails to this e-mail address will not be answered or forwarded.**

8.6. The applicants must be aware that it is their responsibility to ensure 1.) correct emails are provided at the time of submission, 2.) this e-mail notification reaches the intended recipient, and 3.) the email is not blocked by the use of 'spam blocker' software or other means that the recipient's Internet Service Provider may have implemented as a means to block the receipt of certain e-mail messages.

8.7. If for any reason there is a delivery failure of these e-mail notices, **DTRA will not further attempt to contact the applicants.**

9. Agency Contacts

9.1. All administrative and programmatic correspondence should be directed to HDTRA1-BRCWMD-SC@dtrasubmission.net.

Every effort will be made to provide a timely response to all inquiries; however, e-mails may not receive a response. Attachments will not be reviewed.

9.2. Specific technical correspondence regarding the thrust areas as well as the topics corresponding to the thrust areas may be directed to the following e-mail addresses:

Thrust Area 1: BRCWMD-TA1@dtrasubmission.net

Thrust Area 2: BRCWMD-TA2@dtrasubmission.net

Thrust Area 3: BRCWMD-TA3@dtrasubmission.net

Thrust Area 4: BRCWMD-TA4@dtrasubmission.net

Thrust Area 5: BRCWMD-TA5@dtrasubmission.net

9.2.1. Please note that technical correspondence e-mails may or may not be reviewed and responded to; **attachments will not be reviewed.**

9.2.2. Please reference the topic in the subject line of the email, as applicable.

9.2.3. Dialogue that assists the applicants in developing better white papers and invited proposals is encouraged.

9.2.4. Questions regarding debriefing summaries for white papers that are invited to full proposals are encouraged.

9.2.5. Requests to reconsider white papers and/or full proposals, requests for additional information beyond the debriefing summaries for non-invites/non-selections, and rebuttals to the debriefing summary (e.g., additional data, further explanation, etc.) WILL NOT be considered under any circumstances.

10. Period B Topics

PerB-Topic 1: Post-Detonation Radiological and Nuclear Forensics (Thrust Area 1)

Average Award Amounts for PerB-Topic 1:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerB-Topic 1:

- Will be for a base period of three (3) years with two (2) additional years as possible options.

- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-Topic 1 may not be proposed.

Background: This topic explores ways to enable accurate post-detonation analysis of debris from a radiological or nuclear event on a short time scale. The Department of Defense provides the capability to collect and analyze post detonation debris. DTRA is responsible for research and development that will enable this post-detonation forensics. The current methodology includes a radiochemical assay that requires an inordinately long time to obtain statistically accurate results. The advancement of analytical techniques could lead to the ability to accurately analyze debris on time scales shorter than this current methodology. Ideally, this topic seeks novel methodologies which are non-destructive, allowing additional confirmation using the identical sample. Furthermore, a need exists to improve the capability of sample collection; to this end this topic seeks novel methods which have the potential of being more robust under a wide variety of adverse conditions. Also of interest are techniques for material reconstruction that may lead to the determination of the radionuclide source activity after an RDD (radiological dispersal device) detonation.

Impact: The development of advanced post detonation forensics addresses DTRA's counter WMD need to enable prevention of future detonations, enable identification of those responsible, and aid in response and recovery efforts. Such research has the potential to lead to a field deployable system with a real time analysis capability.

Objective: This topic explores novel methods and advancements in the ability to collect samples of material, analyze radioactive debris, and identify signatures from debris analysis in a post detonation environment. Specific interests include the investigation of non-destructive analytical techniques and signatures for material reconstruction. Proposals that engage government laboratory institutions are also encouraged.

Research areas may include but are not limited to the following areas:

- Novel methods for rapid isotopic identification and measurement after a nuclear or radiological detonation
- Non-destructive analytical techniques
- Investigation of techniques with the potential to eliminate the need for time-consuming separative radio-chemistry
- Nuclear Magnetic Resonance (NMR), Neutron Activation Analysis (NAA), laser spectroscopy and mass spectrometry
- Identification of necessary signatures from debris analysis to enable material reconstruction of radiological dispersal devices
- New methods for sample collection after a nuclear or radiological attack
    - Includes water, airborne, and ground collection
- Investigation of the coalescing of airborne radioactive debris
- Exploration of zeolites as adsorbents for debris collection
- Investigation of microstructural analysis tools for post detonation debris analysis

PerB-Topic 2: Methodologies for Autonomous Radiological and Multi-mode Information Collection (Thrust Area 1)

Average Award Amounts for PerB-Topic 2:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerB-Topic 2:

- Will be for a base period of three (3) years with two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-Topic 2 may not be proposed.

Background: Sensing of short range radiological signatures in limited access environments is a difficult problem. Because most direct radiological signatures can often only be detected at close range (< 100 m), mechanisms to employ autonomous platforms permitting close, discrete information collection is desirable. Further, the ability for these platforms to successfully select between a range of detection algorithms and methods based on information gained from secondary signatures also likely to be present (such as magnetic, optical, infra-red, seismic, acoustic, or others) is also potentially necessary. Rapid ability to choose among these disparate methods may require automatic action in a disturbed and quickly changing environment.

Impact: Autonomous platforms capable of using minimal data exchange between each other and/or support from reachback or other command resources will reduce the limitations that may be introduced by dependence on human reaction times. Furthermore, such platforms will be able to successfully navigate a wide range of terrain either on their own or via collaboration with a variety of heterogeneous land/air platforms. Detection systems would also be enhanced by capabilities to collect from challenging environments and return samples to staging points. Additionally, the ability to identify and deploy sensors as part of long dwell (mission dependent, but may extend to months or longer) "leave behind" capability improves persistent surveillance.

Objective: The focus of this topic is on identification of the key scientific obstacles to the deployment of autonomous counter-WMD search assets especially useful for detection of radiological signatures. This topic investigates the identification of approaches towards this kind of autonomous search capability, and does not address the development of hardware for platform mobility or sensors. Proposals that engage government laboratory institutions are also encouraged.

Research areas may include but are not limited to the following areas:

- The investigation of appropriate autonomous search algorithms, communication-minimal cooperation schemes, and detection algorithm/method decision logic supporting the employment of multiple autonomous search platforms against a radioactive source located in a large (~km^2) complex area that may contain obstacles, including shielding structures

- The exploration of multi-mode, one mode being a radiological signature, detection summary reporting methods suitable for employment over long latency small bandwidth wireless communications links
- The identification of methods to deploy long dwell detectors from these platforms as needed, and the identification of methods (i.e. hierarchically distributed sensors) for such platforms to autonomously choose deployment locations for these long dwell detectors based on radiological (i.e. varying signal to noise environments), or operational constraints
- The investigation of autonomously assigning roles to assets, self-organizing techniques, and the optimization of resources for radiological signature sensing

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PerB-Topic 3: Advancing Knowledge of Network Theory for Network Analysis and Response to Attacks (Thrust Area 2)

Average Award Amounts for PerB-Topic 3:
- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerB-Topic 3:
- Will be for a base period of three (3) years with two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-Topic 3 may not be proposed.

Background: In order to preserve essential military capabilities following an attack employing weapons of mass destruction (WMD), one must be able to predict the interdependent responses of the military and national infrastructure networks that define the military capability in response to damage and to changes in network demand that result from such an attack. These include military networks (US and coalition), like the defense strategic communications system, global information grid (GIG) and battlespace networks; non-military networks, the national power grid and transportation grids. Critical considerations in the face of WMD disruption are network availability, interoperability, robustness and recovery. The basic nature of a WMD attack is that multiple nodes will be compromised simultaneously to varying degrees through a multitude of failure mechanisms – some common mode, others implementation-specific, still others as a result of dependencies. The space- and time-correlated details of the damage and the specific nature of the faulty behavior are not known a priori. The WMD stressors to networks can include, for example, widely distributed failures of electronics from nuclear electromagnetic pulse or the long-term denial of network elements or segments due to WMD contamination from nuclear, biological, and chemical (NBC) material as well as direct physical damage. Many current management approaches and policies of network systems contain static assumptions about the structure of network, and they do not account for time dependent variation in traffic type, significant changes in the number of operating nodes, changing security conditions and user demands, including the potential need to prioritize network traffic. In order to understand the critical vulnerabilities and develop avoidance/recovery strategies of such diverse, yet

interdependent networks to WMD attack, a fundamental understanding of the approaches which capture network dynamics is required. This effort is intended to answer questions such as: What are the essential elements of any network? How do different implementations impact on interoperability, vulnerability, survivability and recovery of networks in a WMD environment? What is the mix of implementations that optimize these measures? What data would be most valuable to collect from existing networks to supplement/validate the mathematical and statistical models that will be developed under this effort? What are adaptive network policies and optimization methods? What are routing approaches for networks with variable connectivity and information content? What policies are suitable for managing user demand in the event of major attacks?

Impact: This research will advance theoretical understanding and methods necessary to improve network robustness, management and recovery. Understanding the fundamental properties that contribute to the robustness of networks will support system reliability, survivability and security. This research will identify methods to use indirect information (e.g. peacetime performance indicators or network outages from natural events) for determining what data and how much data are needed to adequately understand the impact of WMD stressors on complex networks. This will impact many areas such as sensor networks, telecommunications, and systems of systems. Defense systems and operating procedures can be optimized to ensure the maintenance of capabilities rather than individual systems, reducing acquisition costs and increasing WMD survivability and operability.

Objective: The objective of this effort is to conduct basic research to advance current knowledge of physical, social and techno-social network behavior and to identify optimal responses to large scale/global, network outages that occur almost simultaneously due to a single Weapons of Mass Destruction (WMD) threat event. High value is placed on science-based mathematical and statistical methods to determine intra- and inter-network failure modes and dependencies and methods to increase network robustness to avoid/minimize WMD stressor impacts. The main thrust of this network topic is to extend prior research to be more specific in defining WMD environments and target networks layers.

Research areas may include but are not limited to the following areas:

- Advances in theoretical understanding or mathematical modeling of the properties of complex networks that cannot be described in terms of graphs or methods used for simple networks and analysis of key aspects of topologies that govern network response to WMD stressors.
- Classification and modeling of attacks on communication and other infrastructure networks to define survivability metric accounting for robustness, fragility, reconfigurable and self-healing of the network.
- Advances in inference algorithms capable of identifying damage via targeted and limited tests. Advances in network control and routing strategies to mitigate network damage. The technique should target design of properly balanced distributed and centralized control of the damage.
- Analysis of optimal structure of networks built to withstand very rare but devastating attacks/outages and capable of fast and least centralized recovery.

- Advances in network forensic for detecting and predicting rare malicious activities and distinguishing them from benign activities over the networks.
- Development of stable and effective network management algorithms for real time allocation of network resources with minimum latency, overhead, and complexity.
- Analysis of key aspects and dynamics in socio-technical networks including cross-layer interactions between social networks and underlying physical and communication layers under WMD stressor impacts.

PerB-Topic 4: Science for Novel Radiation-Hardened Robotics for Sampling and Rescue (Thrust Area 3)

Average Award Amounts for PerB-Topic 4:
- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerB-Topic 4:
- Will be for a base period of three (3) years with two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-Topic 4 may not be proposed.

Background: Recent and historical serious nuclear events have underscored the need for long duration robotic operations in high radiation environments where people cannot operate, or can only safely operate for very limited periods. Unfortunately, robots have not yet demonstrated sufficient radiation hardness to survive for an adequate period of time at the high levels of radiation associated with a serious failure at a nuclear power plant or post thermonuclear explosion near the epicenter of such an event. Robotic systems were not in place or immediately available in the aftermath of the Fukushima Daiichi power plant disaster. The robotic systems later utilized for sampling, observation, and surveillance either suffered electronic/mechanical failures or were not sufficiently sophisticated to fulfill their missions. Various types of robot utilization after a serious nuclear event for forensic sampling, system manipulation, and human rescue would be an essential component of DTRA's post CBNRE event mission.

There is little fundamental understanding of the complex, radiation-induced failure mechanisms in the multi-faceted, integrated electro-opto-mechanical systems represented by robots. Although industry has developed robotic systems to perform conventional function within nuclear power plants and assist with the handling of radioactive materials, robotic systems to deal with non-conventional operating conditions, serious accidents, and nuclear event recovery and forensics are not being adequately explored. For example, these special robots would have to deal with debris, perform tasks deep within a building or structure, provide sophisticated situational feedback and analysis, deal with delicate human rescue tasks, and possibly handle highly radioactive materials while operating in a highly varying radiation environment.

Impact: Radiation hard robots and their associated mechanisms will improve response time while reducing the human risk in dealing with a nuclear event, contribute to the predictive analysis of the nature of the event and the perpetrator, minimize both short and long term effects, provide for effective remediation, and assist in restoration. In the case of human exposure, robots can provide safe rescue without additional radiation exposure to first responders.

Objective: The objectives of this topic are to conduct theoretical and some experimental research to further the fundamental understanding of the radiation induce failure mechanisms of robotic system and components, and to determine the hypothetical sensitivity of particular sub-assemblies and components. The emphasis will be on understanding the basic mechanisms of radiation interaction with the variety of robotic subsystems. In addition, the vulnerability of the overall assembly of subsystems should be explored in order to determine where redundant systems and additional robustness are important. The approach will be based on a combination of theory, simulation, and some basic research experiments. New test capabilities for characterizing radiation effects in robotic systems will be developed, taking into account the emerging needs for specialized autonomous systems.

This topic is open to any basic research proposal that directly addresses the radiation hardness of robots or the performance of robots in high radiation environments. Proposals must be for basic scientific research and not for device/component development or system engineering. While proposals need to address the relevance of the research to DTRA's counter weapons of mass destruction mission and specifically the use of robots and robotics for rescue, reconnaissance, and remediation in the aftermath of a nuclear event, the use of specific applications or scenarios is discouraged. This topic seeks to develop a fundamental understanding of interaction of radiation and radioactive material (dust, debris, water, gas) with robots and robotics. Studies that focus on cataloging effects or determining relative radiation hardness are discouraged. Prospective investigators are encouraged to collaborate with DoD facilities, DoE laboratories, NASA resources, FFRDC's, and/or industrial and academic laboratories.

PerB-Topic 5: Basic Science of Laser Filamentation for Counter-Weapons of Mass Destruction Utilization (Thrust Area 3)

Average Award Amounts for PerB-Topic 5:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerB-Topic 5:

- Will be for a base period of three (3) years with two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-Topic 5 may not be proposed.

Background: Experiments at the University of Michigan in 1995 demonstrated a unique offsetting pair of non-linear phenomena that allows the long distance propagation of powerful

femtosecond laser pulses through transparent gaseous, liquid or solid media with a significant portion of the energy remaining in an intense and highly localized lighted core surrounded by ionized plasma. This laser filamentation is associated with several non-linear effects which have numerous prospective applications. This topic focuses on research on the basic science that might enable possible applications related to DTRA's mission on counter weapons of mass destruction, in the chemical, biological, radiological, nuclear, and high explosive (CBRNE) regimes.

The laser filament phenomena has been described as a successive interaction of the optical Kerr effect, which focuses the beam as it propagates, and the creation of a surrounding ionized plasma, which leads to beam defocusing. These successive and complex interactions allow for continuous laser core regeneration over extended distances within the transparent media through which the beam propagates. Prior work has observed pulse compression which broadens the spectral bandwidth. For example, an initial 800 nm femtosecond pulse from a Ti:sapphire laser will spread across the visible and near IR spectrum creating a "white light" or super continuum pulse.

Numerous prior applications of these phenomena have been explored, including laser breakdown spectroscopy and fluorescence. These filaments can act as a guide for high-voltage discharges such as lightening and, possibly, EMP effects. In addition to the production of high-order harmonics, power beaming, EM propulsion, terahertz pulse emission, creation of laser chirps, and terrestrial laser probes have all been suggested as possible applications. Other ideas may include remote intense X-ray production, and high altitude ionization effects.

Impact: Laser filamentation offers the potential to reduce risk and increase response distance by sensing and interacting with matter at great distances with little loss of power or increase in spot size. Laser filamentation and ultra-short laser pulses also offer a convenient platform for accessing non-linear phenomena, which are especially useful for the generation of broadband light, X-rays, γ-rays, THz pulses, and EMPs.

Objective: The objectives of this topic are to conduct theoretical and some experimental research to further the fundamental understanding of the laser filament phenomena and the associated plasma radiation mechanisms. This research will determine the possible efficacy of laser filaments for environmental considerations associated with a CBRNE circumstance, the use of these phenomena for WMD detection along with their constituents and the development of new utilization concepts and interactive testing to evaluate the possible use of these phenomena for DTRA mission focused activities. The emphasis will be on the basic mechanisms of pulsed laser radiation and propagation with ancillary ionized plasma interactions. In addition, the vulnerability of the propagation process should be explored in order to determine where the limitations and robustness are important. The approach will be based on a combination of theory, simulation, and basic research experiments. New test capabilities for characterizing radiation effects should be developed, taking into account the emerging and prospective needs for sensing, detection, power transport, broadband focused light transmission, and terahertz signal approaches, among other possibilities.

This topic is open to any proposal that directly addresses a basic science research focus on laser filamentation for enabling possible counter-weapons of mass destruction applications. The proposal must make the connection between the proposed basic physics research and countering chemical, biological, radiological, nuclear, or high explosive weapons. Possible applications of laser filamentation may be in detection, sensing, protection, weapon/agent defeat, remediation, and/or weapon effects replication. Submissions that focus on specific applications (not the basic enabling science), applied configuration research, or systems engineering are discouraged. Researchers are encouraged to gain an understanding of DTRA's core mission and propose novel research directions for laser filamentation that further DTRA's counter-WMD mission. Prospective investigators are encouraged to collaborate with DoD facilities, DoE laboratories, NASA resources, FFRDC's, and/or industrial and academic laboratories.

PerB-Topic 6: Production of Reactive Oxygen Species in Cancer Stem Cells Subsequent to Acute Radiation Exposure (Thrust Area 3)

Average Award Amounts for PerB-Topic 6:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerB-Topic 6:

- Will be for a base period of three (3) years with two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-Topic 6 may not be proposed.

Background: The current paradigm for defining the interactions between ionizing radiation and biological matter is largely based upon inference derived from secondary observation, primarily because real-time interrogation of irradiated systems was previously delimited by the available technologies for observing cellular processes without causing cell lethality. Indirect markers suggest that DNA damage, especially double strand breaks, is the ultimate cause of cell damage and/or death and, in the case of exposure to low-LET radiation (Linear Energy Transfer), may be mediated by reactive chemical species formed subsequent to the splitting of intracellular water molecules. Although specific laws predicting the kinds and amounts of injury in a given cell resulting from radiation exposure have yet to be elucidated, certain rules of thumb are applied to estimating radiation effects. Among the most recognized are those developed by French radiobiologists Bergonie and Tribondeau, who concluded that radiosensitive cells generally possess three properties: high division rate, long dividing future, and lack of differentiation.

Cancer research in the last few years suggests that both solid tumor and blood cancers harbor small populations of anaplastic cells that may drive tumor growth and metastasis through sustained self-renewal and multi-lineage differentiation. In apparent contrast to the Bergonie and Tribondeau rules of thumb, these cancer stem cells (CSCs) demonstrate remarkable resistance to radiation treatments sufficient to induce death in bulk tumor cells. The observed radioresistance has been attributed to a number of factors related to enhanced DNA repair and expression of

anti-apoptotic proteins; however, specific identification of resistance mechanisms has been hampered by the ability to culture and purify adequate concentrations of CSCs for deeper interrogation. Recent advancements in culturing techniques (e.g., adherent culturing) that allow expansion of homogenous CSC populations provide promise for developing a unique model system to study mechanisms of radioresistance in human cells.

Because conventional wisdom suggests that deleterious effects related to ionizing radiation exposure (especially external exposure) are causally related to interactions between reactive oxygen species (ROS) and nuclear DNA, discerning the composition and relative concentrations of specific ROS following irradiation represents a reasonable starting point for the systematic study of interactions between radiation and biological matter. The overarching goal for this research topic is to contribute to fundamental knowledge regarding the biological consequences of radiation exposure by directly interrogating cellular systems using newly available methods and model systems.

Impact: Advancing the current mechanistic understanding of cellular response to acute ionizing radiation will allow the development of better pre-treatments, prophylaxes, and countermeasures for warfighters and others that may be exposed to radiation in the event of a deliberate or accidental nuclear release. In addition, data resulting from such studies will allow the development of experimentally validated risk models and can assist in the establishment of reasonable human protection standards.

Objective: The primary goal is to develop fundamental knowledge related to the cellular effects of radiation exposure by using cultured CSCs as model systems. Preference will be given to research teams with demonstrated history in culturing CSCs, maintaining pluripotency, and selecting cell populations with specific potency. The particular focal point is quantifiably and reproducibly describing composition and relative concentrations of ROS upon exposure to acute gamma- or x-irradiation.

Research areas may include, but are not limited to:

- Interrogation of cellular effects related to acute ionizing radiation exposure, with the range of doses to include those typically delivered during radiation therapy for cancer treatments (0 - ≥ 8 Gy). Pluripotent as well as differentiated cell cultures should be evaluated to provide a basis for comparison.
- Monitoring of composition, and biological half-lives, of ROS previous to and upon cellular irradiation.
- Correlation of ROS levels with other cellular responses, particularly those related to DNA damage.

PerB-Topic 7: Multi-scale Coupling in Simulations of Multi-component Reacting Systems (Thrust Area 4)

Average Award Amounts for PerB-Topic **7**:

- Single Scope Awards will average approximately $150,000 per year.

- Only Single Scope Awards will be reviewed for this topic.

Award Structure for PerB-Topic 7:
- Will be for a base period of three (3) years with two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-Topic 7 may not be proposed.

Background: It is desired to neutralize Weapons of Mass Destruction (WMD) using air-dropped ordnance that must penetrate or otherwise gain entry into WMD locations, activate a dispersal mechanism (typically driven by high explosives), couple with WMD items, and neutralize these items. Current inventory munitions impact targets at rates of ~300 m/s. Fragments driven by high explosives have initial velocities of 1,000-2,000 m/s. Shaped charges travel on the order of multiple km/s. As a result, counter-WMD events occur at high rates (10^2-10^7 s^{-1}) where physical and chemical changes can take place at nanosecond times scales, and necessarily include a wide variety of highly-heterogeneous materials such as: earth materials, energetic materials (e.g. high explosives, metal particles, reactive materials, etc.) and WMD component materials (e.g. chemical, biological, radiological, etc.), spanning many magnitudes of length scales and time scales.

WMD-defeating systems are designed by using engineering hydrocodes that simulate the behavior of proposed weapon designs and troubleshoot solutions prior to the performance of expensive mid/full-scale tests. We are currently supporting many projects on meso-scale modeling of multi-scale, multi-component (heterogeneous) solid-sate systems that are initiated with a shock wave, causing reactions that yield gas-phase combustion and reaction products. We are also currently supporting measurements and models of high temperature, high pressure reactions associated with blast weapons, and fluid dynamic modeling of turbulent flows associated with weapon detonation and subsequent fireball generation.

With the current massively parallel computing power, it may now be possible to fully resolve the quantum mechanics of chemical kinetics, coupled with micro-scale of reacting heterogeneous explosives (including reactive cases or reactive liners), coupled with complex meso-scale physics of detonation and shock propagation, coupled with macro-scale blast effects on surrounding structures, and continue to simulate extended space and time by tracking the explosive plume to simulate the entire event, spanning many orders of magnitude of time and space. While each model is dominated by its own characteristic length and time scales, the challenge lies in interfacing/coupling the models and collapsing/linking/windowing the characteristic scales to satisfy the governing equations at each scale. Such an integrated end-to-end approach offers the best hope of predictive simulations of practical interest, whose results can be trusted.

Impact: This research will enable accurate weapon simulations that will improve lethality estimates for current weapons to defeat WMD, and it will allow intelligent design of new Counter-WMD weapon systems without needing multiple tests at multiple scales, making the development of new systems much cheaper and more efficient.

Objective: This topic seeks integrated weapon effect simulations where the power of computation at each scale (micro-, meso- and macro-) is fully exploited and properly coupled and scaled up to the higher level. To achieve this goal, we require a hierarchical approach where quantum mechanics predicts the molecular scale, accurate micro-scale material characterization; chemical reactions predict the meso-scale, shock physics; turbulence models predict the macro-scale mixing and transport; and, fluid dynamics predicts the entire continuum weapon effect. To bridge each scale, information could be synthesized into appropriate reduced-order coupling models that will enable truly micro-scale, physics- and chemistry-based simulations; however, strategies for accurate and efficient nesting of multi-level models must be carefully considered. In particular, the reduced-order models must accurately account for the compressible, inhomogeneous, highly time-dependent and extreme coupling that occurs between scales. When higher-order bases are used for more accurate predictions versus lower-order bases for less accurate predictions, systematic improvement in nodal density and arrangement could be optimized, using the difference in the solution between lower and higher bases to control and minimize computational time and error.

Research areas may include but are not limited to:

- Materials (solid state) modeling to computational fluid dynamics
- Continuum methods, finite volume, finite element and finite difference methods
- Particle methods, adaptive-mesh, mesh-free, and mesh-less approaches
- Eulerian or Lagrangian or Combined Approaches

PerB-Topic 8: Novel Signatures and Methodologies for Characterizing Nuclear Event Sites and Activities (Thrust Areas 1 and 5)

Average Award Amounts for PerB-Topic 8:

- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerB-Topic 8:

- Will be for a base period of three (3) years with two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-Topic 8 may not be proposed.

Background: Verification and monitoring technologies are noted for their importance to support nuclear arms control and nonproliferation, and assure compliance with current and future nuclear weapon related treaties/agreements. It is important to conduct basic research to significantly improve existing approaches, or to identify and understand novel approaches, in order to explore opportunities for verification and compliance of the "treaty/agreement-after-next," as well as, significantly enhance verification regimes of current treaties. Recent events and historical trends serve to emphasize the continuing need for improvements in nuclear test monitoring such as may be conducted through on-site inspections or local area monitoring, wide area monitoring for illicit nuclear activities, and the importance of supporting fundamental

advances in these areas. Seismic methods provide a major means of detecting and characterizing underground explosions. These methods can be augmented by other techniques; e.g., infrasound, hydroacoustic, or radionuclide networks. Sensing and characterization of suspected nuclear events may involve additional signatures or approaches than those of traditional monitoring systems. For example, there may be environmental factors near an underground explosion that are disturbed and which may be measureable during an on-site inspection. Basic research into observable phenomena may yield novel means for understanding events that represent potential nuclear explosions.

Impact: Advancements in fundamental science may foster future technologies and analysis methodologies help discriminate between nuclear and non-nuclear events, and processes; that extend both the lower limits and reliability of yield determination; enhance early detection of noncompliance; and, help assure nonproliferation of nuclear weapons. Science factors can facilitate early indication of intent to proliferate, as well as provide flexibility to identify events if access is available only in the long-term. It is desirable to advance knowledge of both near time measurements in the days and weeks following an event and longer term understanding of signatures that may extend the ability to verify and characterize given data collection months or years post-event. Scientific and technical approaches should enable a non-nuclear weapon state to participate in assurance of compliance with treaties/agreements, while not enabling proliferation capability to the participant.

Objective: The objective of this topic is to foster physical or life sciences basic research into alternative phenomena and novel methods to advance technologies and approaches in support of treaties/agreements, arms control, and nonproliferation.

Research areas may include but are not limited to:

- Conducting theoretical, computational, or experimental studies of novel observables to significantly improve understanding of topographical, geological, or depth factors that affect phenomena of non-seismic signatures measured for determination of weapon yield, type of event and reaction history.
- Conducting theoretical, computational, or experimental studies of fundamental changes in surface physical observables (or environmental factors) that result from above and underground tests.
- Exploring the generation, propagation, properties, and measurements of basic physics, e.g., electromagnetic phenomena, that may arise from explosions; e.g., changes in geophysical electrical properties, generation of currents, pulses, etc.
- Improving the prediction of chemical fractionation and speciation and neutron activation products starting from the plasma immediately after detonation to ambient temperatures in the underground environment and seepage to the atmosphere (i.e., fate and transport of event debris).
- Enhancing understanding for the concentration of isotopes by several orders of magnitude to increase probability of detection of trace or short-lived isotopes with half-lives on the order of hours or days; e.g., novel bio-concentration or physical chemistry processes to enhance selectivity.

- Enhancing understanding for the detection of water-borne radionuclides; e.g., through either selective absorption or bulk concentration of potential event products in large aqueous samples.
- Identification of pathways and biological half-lives in flora, fauna, or micro-organisms that may allow prediction or measurement of bio-concentration of isotopes to indicate recent underground explosions. These may be represented in a broad potential range of environments (terrestrial and aqueous, tropical, desert, etc.).

PerB-Topic 9: Novel Materials and Methods for Sensing and Transparency to Secure WMD (Thrust Area 5)

Average Award Amounts for PerB-Topic 9:
- Single Scope Awards will average approximately $150,000 per year.
- Multidisciplinary Awards will average approximately $350,000 per year.

Award Structure for PerB-Topic 9:
- Will be for a base period of three (3) years with two (2) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-Topic 9 may not be proposed.

Background: Monitoring for nonproliferation compliance and secure storage or transport of WMD-related materials or components contributes to reducing the WMD threat. Current uses for unattended monitoring systems include installation of sensors in nuclear facilities to act on a continuous basis to assist in safeguards; e.g., to monitor materials and processes in an effort to identify changes and queue further inspection as necessary. Other uses of unattended sensors may include distributed sensor networks in the field to detect nuclear or non-nuclear WMD and materials. Knowledge of tampering helps secure WMD by establishing the reliance which may be put upon data from such sensors, and needs to be resistant to spoofing. Basic physical principles can help ensure integrity of monitoring/sensing of properties for attached or near-by objects whether they change or remain fixed; e.g., integrity of seals, radiation levels, airborne particles/molecules, electrical currents, temperatures, humidity, location, etc. A challenge associated with cooperation is a preference toward minimally invasive techniques for monitoring and inspections. This challenge may include creating technical solutions with the ability to sense general but useful black-box properties of containers for which knowledge of the internal content may not be allowed in detail. In addition to scientific principles that promote future hardware, basic research into secure algorithms and software principles may yield insights into providing transparency while protecting those sensitive details reached in agreements or treaties. Transparency is desired for strong verification regimes to build confidence between parties to the agreement. A further challenge to monitoring is the need to be able to inspect arrays of measurement data, which may include mobile sensors, while understanding and discriminating signatures which may include very small signals. Treaties/agreements to reduce the threat of WMD will benefit from both (1) materials with built-in passive or active sensing properties, and (2) novel methods for securing weapons and increasing transparency.

Impact: Basic research will support future opportunities to build or extend partnerships in WMD threat reduction. For example, significant improvements in the ability to eliminate, secure, or consolidate WMD, related materials, and associated delivery systems and their infrastructure will build assurance in our ability to partner with willing countries to reduce the threat from WMD in the spirit of Cooperative Threat Reduction. Sensing material may, for example, be applied to weapons, systems, sites, or locks/seals as indicators of activity or integrity between inspections. Novel sensing materials can help provide unique assurance against tampering, thereby assisting verification of compliance. This may enable confidence: in greater reductions in arms; for agreements with new signatory nation states regarding their nuclear forces (or non-nuclear weapons); and, in existing or future treaties/agreements.

Objective: The primary objectives of the research sought in this topic are: (1) to explore phenomena in materials that can provide passive or active indicators of interference with unattended monitoring (i.e., 24/7 sensing); (2) to understand interactions that reveal the nearby but greatly displaced presence of novel tag materials (i.e., not incremental improvements in RFIDs) structured for cooperative efforts; e.g., locate transported objects by sensors within ranges of 10s of meters; and, (3) to explore scientific methods that provide transparency into activities in a partner nation's facilities while being flexible in measurement and reporting (i.e., adjustable to not intrude in areas of knowledge protected by agreement).

Research areas may include but are not limited to:

- Study properties of unique micro/nanostructures that sense and store memories of the type, magnitude and time history of actions that change the structure. For example, investigation of changes in the state of materials on the molecular level that provides passive indication of external manipulation, such as unique changes in molecular structure; electrical, magnetic, or thermal properties; etc.
- Investigate active phenomena (e.g., processes that store and transduce energy) that help passive structures such as those identified above. For example, signal enhancement via methods to control molecular storage in caged molecules or nanotubes and subsequent energy generating interactions such as charge release.
- Explore quantum states that provide unique information that support knowledge of tampering or the state of objects; e.g., atom interferometry etc. for mass distribution, entanglement/decoherence of states to identify tampering, weak measurements of observables; etc.
- Explore properties—such as electrical, magnetic, radiative, chemical volatility etc.—of novel material structure and function, and how these interact with photons, acoustic energy, chemical sensors etc. to provide measureable observables such as location.
- Create monitoring algorithms or mathematical methods of complex systems to assist with transparency. For example: improve understanding of detector placement/type relative to improving CBRNE monitoring that clarifies what is present, and where. Explore the means to analyze sensor data histories for evidence of tampering, while characterizing false positives and false negatives.

PerB-YIP-Topic 1: Post-Detonation Radiological and Nuclear Forensics (Thrust Area 1)

Young Investigator Awards for PerB-YIP-Topic 1 will average $100,000 per year.

Awards for PerB-YIP-Topic 1:

- Will be for a base period of two (2) years with three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-YIP-Topic 1 may not be proposed.

For topic description, please see PerB-Topic 1.

PerB-YIP-Topic 2: Methodologies for Autonomous Radiological and Multi-mode Information Collection (Thrust Area 1)

Young Investigator Awards for PerB-YIP-Topic 2 will average $100,000 per year.

Awards for PerB-YIP-Topic 2:

- Will be for a base period of two (2) years with three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-YIP-Topic 2 may not be proposed.

For topic description, please see PerB-Topic 2.

PerB-YIP-Topic 3: Advancing Knowledge of Network Theory for Network Analysis and Response to Attacks (Thrust Area 2)

Young Investigator Awards for PerB-YIP-Topic 3 will average $100,000 per year.

Awards for PerB-YIP-Topic 3:

- Will be for a base period of two (2) years with three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-YIP-Topic 3 may not be proposed.

For topic description, please see PerB-Topic 3.

PerB-YIP-Topic 4: Science for Novel Radiation-Hardened Robotics for Sampling and Rescue (Thrust Area 3)

Young Investigator Awards for PerB-YIP-Topic 4 will average $100,000 per year.

Awards for PerB-YIP-Topic 4:
- Will be for a base period of two (2) years with three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-YIP-Topic 4 may not be proposed.

For topic description, please see PerB-Topic 4.

PerB-YIP-Topic 5: Basic Science of Laser Filamentation for Counter-Weapons of Mass Destruction Utilization (Thrust Area 3)

Young Investigator Awards for PerB-YIP-Topic 5 will average $100,000 per year.

Awards for PerB-YIP-Topic 5:
- Will be for a base period of two (2) years with three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-YIP-Topic 5 may not be proposed.

For topic description, please see PerB-Topic 5.

PerB-YIP-Topic 6: Production of Reactive Oxygen Species in Cancer Stem Cells Subsequent to Acute Radiation Exposure (Thrust Area 3)

Young Investigator Awards for PerB-YIP-Topic 6 will average $100,000 per year.

Awards for PerB-YIP-Topic 6:
- Will be for a base period of two (2) years with three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-YIP-Topic 6 may not be proposed.

For topic description, please see PerB-Topic 6.

PerB-YIP-Topic 7: Multi-scale Coupling in Simulations of Multi-component Reacting Systems (Thrust Area 4)

Young Investigator Awards for PerB-YIP-Topic 7 will average $100,000 per year.

Awards for PerB-YIP-Topic 7:

- Will be for a base period of two (2) years with three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-YIP-Topic 7 may not be proposed.

For topic description, please see PerB-Topic 7.

PerB-YIP-Topic 8: Novel Signatures and Methodologies for Characterizing Nuclear Event Sites and Activities (Thrust Areas 1 and 5)

Young Investigator Awards for PerB-YIP-Topic 8 will average $100,000 per year.

Awards for PerB-YIP-Topic 8:

- Will be for a base period of two (2) years with three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-YIP-Topic 8 may not be proposed.

For topic description, please see PerB-Topic 8.

PerB-YIP-Topic 9: Novel Materials and Methods for Sensing and Transparency to Secure WMD (Thrust Area 5)

Young Investigator Awards for PerB-YIP-Topic 9 will average $100,000 per year.

Awards for PerB-YIP-Topic 9:

- Will be for a base period of two (2) years with three (3) additional years as possible options.
- Pre-application white papers and proposals that outline scope and effort for only the base period and do not propose options are also acceptable, however, base period and option combinations other than those detailed for PerB-YIP-Topic 9 may not be proposed.

For topic description, please see PerB-Topic 9.